5.4 Other Transportation

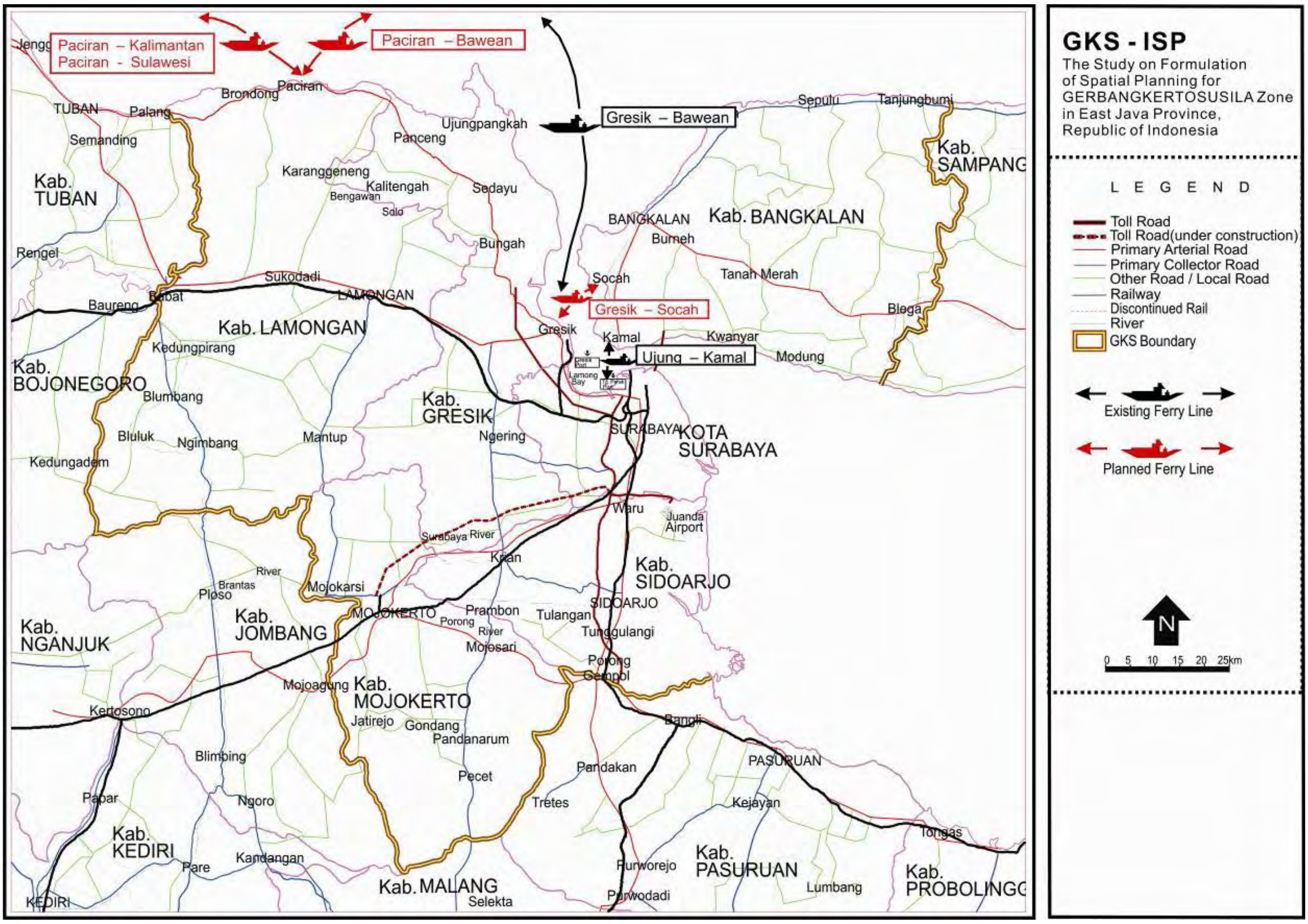
5.4.1 Ports

1) Port Development Plans

Passenger ferry development plans for GKS are presented in Source: Regional Transportation Plan East Java (Tatrawil Jawa Timur) 2009-2029,

Transportation Agency (Dinas Perhubungan) of East Java Province

Figure 5.4.1. The existing interisland passenger ferry services at Tg. Perak are planned to be relocated to Paciran, Kabupaten Lamongan, in order to increase the cargo handling capacity of Tg. Perak Port. In addition, passenger ferry services connecting Gresik and Socah, Kabupaten Bangkalan, where the Madura Industrial Seaport City is planned, will enhance the connectivity between the Surabaya metropolitan area and Madura Island.



Source: Regional Transportation Plan East Java (Tatrawil Jawa Timur) 2009-2029,
Transportation Agency (Dinas Perhubungan) of East Java Province

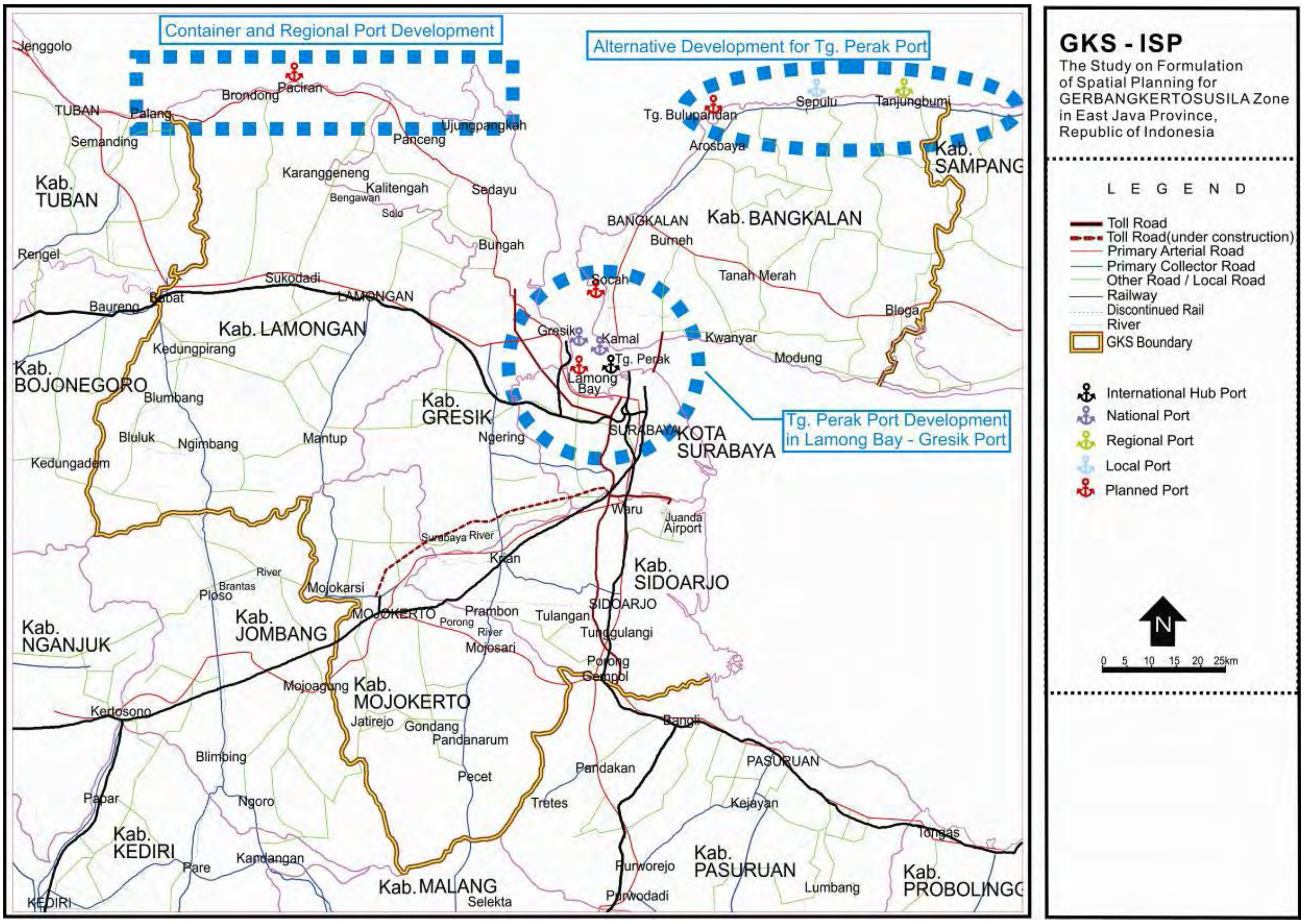
Figure 5.4.1 Passenger Ferry Development Plan for GKS

Port development plans for GKS are presented in Source: Regional Transportation Plan East Java (Tatrawil Jawa Timur) 2009-2029,

Transportation Agency (Dinas Perhubungan) of East Java Province

Figure 5.4.2. Since Tg. Perak Port, which is the second largest port in Indonesia, is already operating at full capacity, there are several candidate sites for a new port to meet further maritime traffic growth. So far, the Lamong Bay Reclamation Project has been agreed upon with a limited scale of 50 hectares as a compromise solution, considering its environmental impact vis-a-vis the urgent need to handle increasing container traffic. This has already been put on the implementation track.

In the northern coastal area of Kabupaten Lamongan and Gresik, various types of ports are to be developed including the Paciran passenger ferry port, Sedayu Lawas cargo port, Brondong fish port, and other industrial ports developed by the private sector. In the northern coastal area of Kabupaten Bangkalan, there are several ports to be developed including an international container port at Tg. Bulu Pandan and other traditional ports in Sepulu and Tg. Bumi, which is also a base port for developing an offshore oil field. Some of the planned cargo ports could be developed as an alternative to Tg. Perak Port.



Source: Regional Transportation Plan East Java (Tatrawil Jawa Timur) 2009-2029,
Transportation Agency (Dinas Perhubungan) of East Java Province

Figure 5.4.2 Port Development Plan for GKS

2) JICA Port Development Study

According to "The Study for Development of the Greater Surabaya Metropolitan Ports in the Republic of Indonesia" (JICA, 2007), the most urgent critical issue is not the port itself in the case of Surabaya, but the access channel along the Madura Strait. While the access channel will be improved to have a 12-meter depth and a 200-meter width in the short term, it was forecast that seaborne traffic will exceed the maximum channel traffic capacity of over 54,000 ships per year by 2025. Therefore, new port(s) away from the access channel will be necessary.

Thus, for the long term, the JICA Study Team for GKS study proposes the siting of a new container port at Tg. Bulu Pandan in Kabupaten Bangkalan. Facing Java Sea, the port will be able to accommodate the largest Panamax container ships. This will be the most important gateway port and will greatly influence the economy of GKS.

As for non-container demand, any port having non-container infrastructure will need to adjust (mainly expand) its operating capacity in the long term. Although most of the available coastline along the Madura Strait will be densely used for ports and shipping around the year 2015, Socah on the Madura side is expected to still be available. Hence, this study has recommended that a Socah site be developed as a non-container port, handling general cargo and others, with up to 12 m in depth.

Gateway port development may have a profound impact on regional development. Particularly, when a gateway port is located in an underdeveloped area and the port's direct hinterland is developed as well, greater synergy can be expected than individual developments. One of the reasons why this study has selected these two candidate sites for a gateway port is their spaciousness not only for the port but also for direct hinterland development. These two projects are supported and promoted by the provincial government as well.

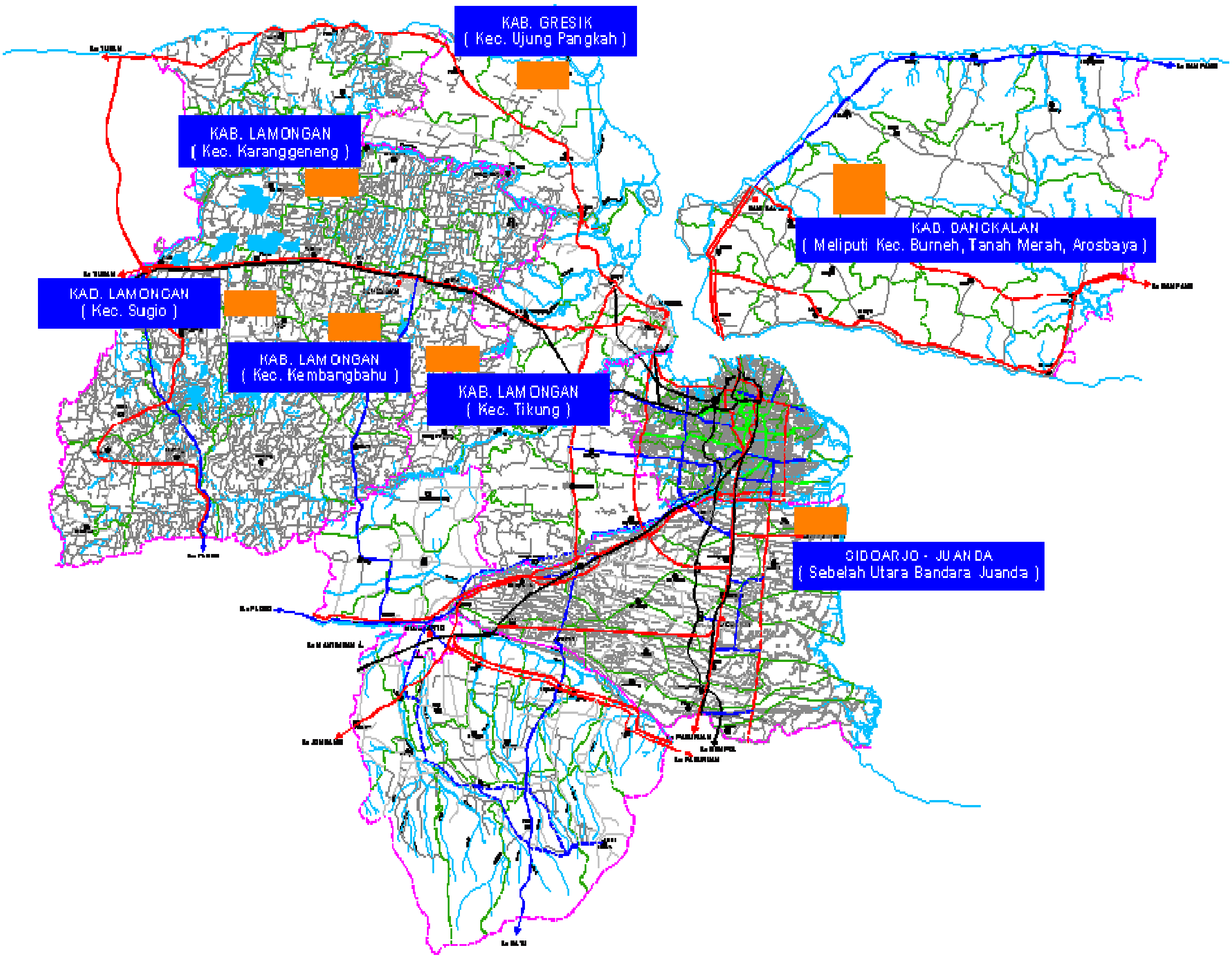
5.4.2 Airports

While Juanda Airport is one of the primary hub airports in Indonesia, it is also the center of the Indonesian Navy. Since the lone runway as well as the airspace is shared with the Navy, the capacity for civil aviation is limited. The airport is already nearing its full capacity with a current headway of 1 minute and 20 seconds during peak hours. As for the terminal buildings, their capacities of 6 million passengers per year have already been exceeded with the buildings currently accommodating 8.5 million passengers per year.

While the construction of additional runways and terminal facilities is a partial solution, the development of a new airport has also been considered. Source: Regional Transportation Plan East Java (Tatrawil Jawa Timur) 2009-2029,

Transportation Agency (Dinas Perhubungan) of East Java Province

Figure 5.4.3 shows several alternative locations for the new airport. If the new airport will be located in Kabupaten Bangkalan or Kabupaten Gresik, the airspace may still overlap with that of the Juanda Airport. On the other hand, if it is located in Kabupaten Lamongan, it may be able to serve not only GKS but also Tuban and Bojonegoro.

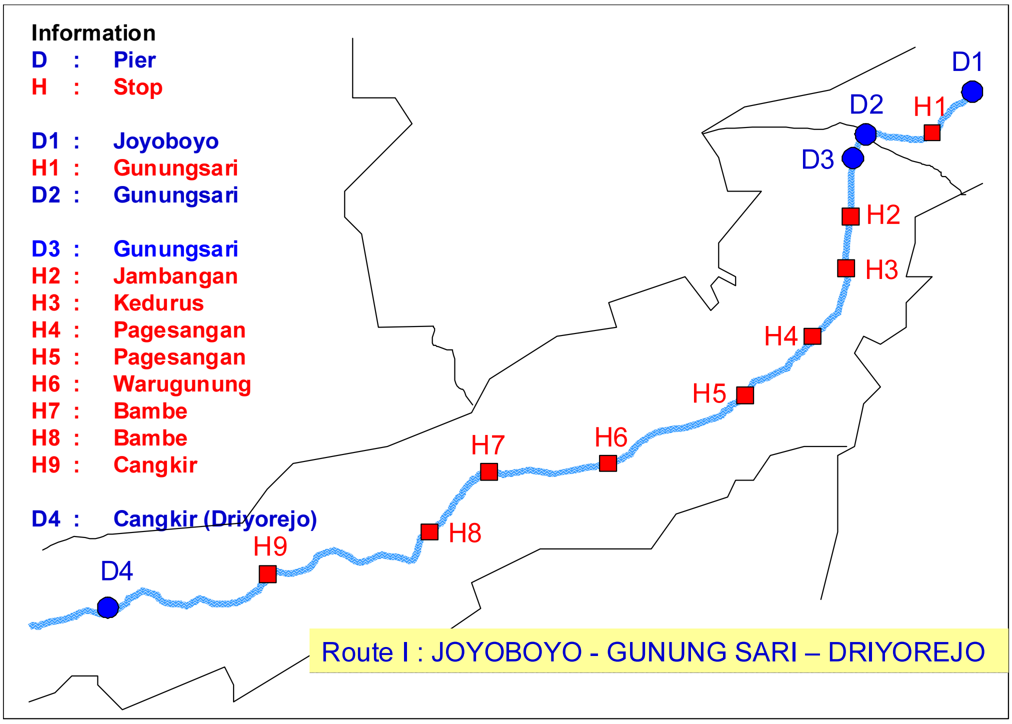


Source: Regional Transportation Plan East Java (Tatrawil Jawa Timur) 2009-2029, Transportation Agency (Dinas Perhubungan) of East Java Province

Figure 5.4.3 Alternative Locations for a New Airport in GKS

5.4.3 Water Bus Transportation

As shown in Figure 5.4.4, there is a plan for a water bus transportation network along the Surabaya River. The network will be divided into two routes by the river dam, namely Joyoboyo–Gunung Sari (Kota Surabaya) and Gunung Sari–Driyorejo (Kab. Gresik). The water buses will be operated with about five round trips per day, mostly for tourism purposes in the initial stage.



Source: Regional Transportation Plan East Java (Tatrawil Jawa Timur) 2009-2029, Transportation Agency (Dinas Perhubungan) of East Java Province

Figure 5.4.4 Planned Water Bus Route

TRANSPORTATION DEMAND SCENARIO

6. TRANSPORTATION DEMAND SCENARIO

6.1 Development of Forecast Models

1) General

Basically, forecasting the future traffic demand is done by applying the conventional four-step methodology, namely trip generation and attraction model, trip distribution model, modal share model, and traffic assignment model. These steps can be grouped into two, steps to build models for estimating future OD matrix and for estimating traffic volumes on the network. The former step comprises the trip generation and attraction model, trip distribution model, and modal share model; and the other step is the traffic assignment model. Building the models in the former step can be done by using Microsoft Excel and the latter by using the JICA STRADA, which is an integrated software developed by JICA as a tool for model development based on the four-step methodology.

i) Trip Generation/Attraction Model

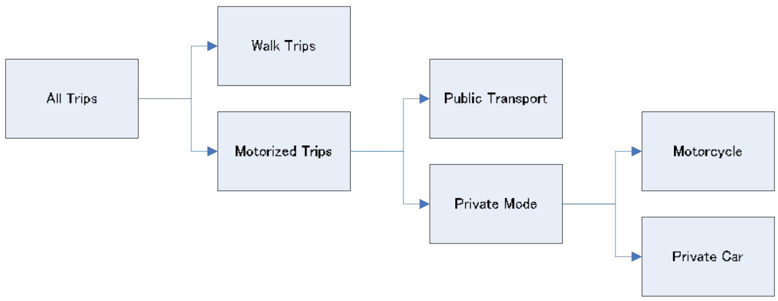
This model consists of the trip production model and the trip generation and attraction model. The former forecasts the total number of trips in the whole study area by using the trip rate of specific personal attributes, which can be obtained from an analysis of the commuter survey data. The latter model is used to calculate trip generation and attraction by traffic analysis zone. This model can be described by a comparison of the trip generation and attraction, as well as the socio-economic indicators per traffic analysis zone.

ii) Trip Distribution Model

A distribution model calculates the trip distribution between traffic analysis zones. There are several models for a distribution model, the most popular of which is a gravity model, which consists of trip generation and attraction, and the impedance between traffic zones. In this study, several models were examined and the most suitable one was selected.

iii) Modal Split Model

A general structure of modal choice is shown in the figure below. First, all trips are divided into walk trips and motorized trips. Then, the motorized trips are divided into public and private transportation modes. When this structure is applied, three split models will be built.



Source : JICA Study Team

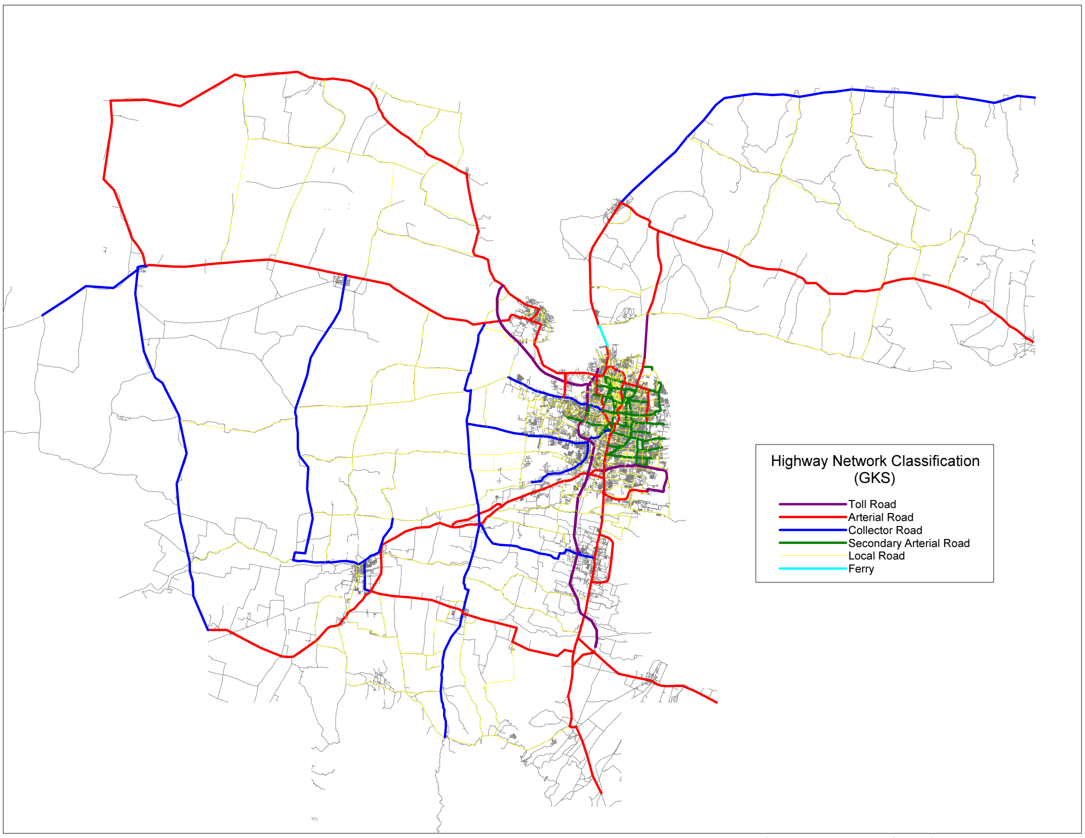
Figure 6.1.1 General Structure of a Modal Choice Model

iv) Assignment Model

A traffic assignment model is one that assigns the OD matrix generated by a modal split model (or distribution model) on a transportation network and calculates the traffic volume on each link of the network. Every road link in the network has information about transportation facilities and service levels. The travel speed on every link varies because of the differences in traffic volume, based on its QV equation. Then, the shortest time between origin and destination zones is determined, and the volume of trip distribution between specific zones is assigned on the shortest route.

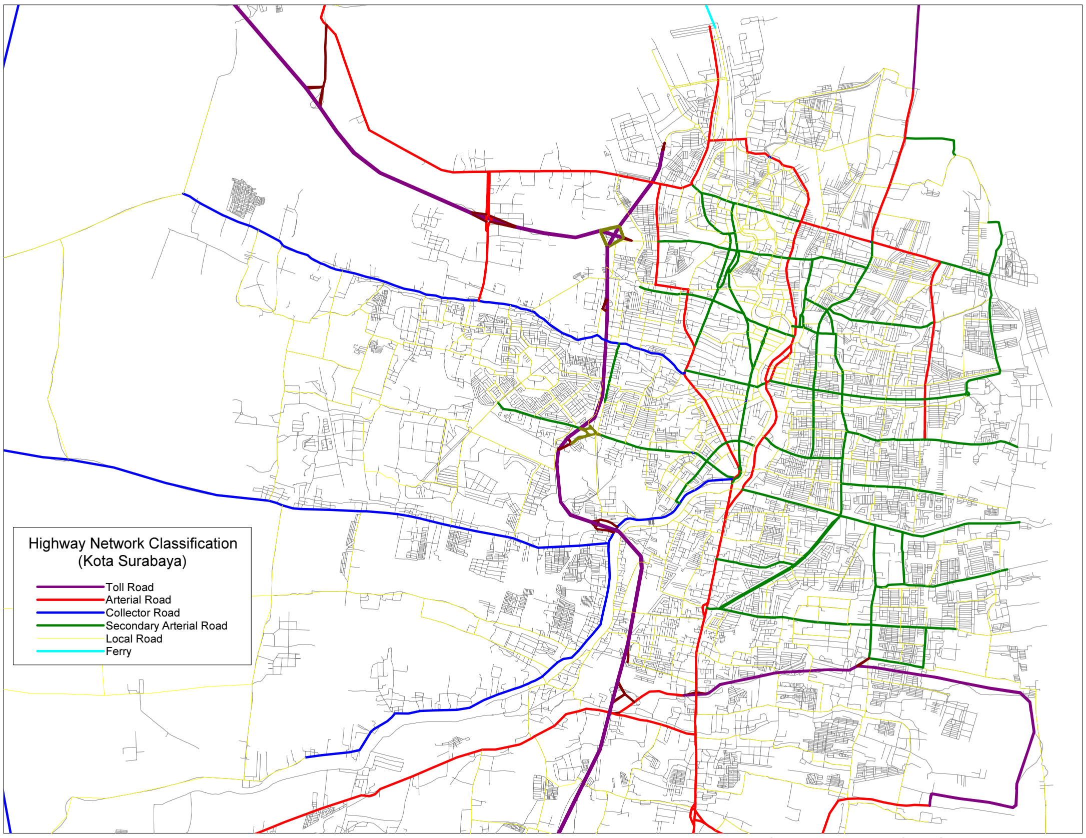
2) Road Network Development

For traffic assignment, network development is required. The network database developed for the study consists of two categories: a highway network and a public transportation network (transit network). A highway network comprises nodes representing intersections or junctions and links which have nodes at both ends, representing road segments. Each link should have attributes, such as travel speed, link length, and possible capacity, which will be used for searching the minimum-cost route in the network. The attributes are specified according to functional classes of road: toll road, arterial road, collector road, secondary arterial road, and local road.



Source: JICA Study Team

Figure 6.1.1 Base Year Network in GKS for Demand Forecasting



Source: JICA Study Team

Figure 6.1.2 Base Year Network in Kota Surabaya for Demand Forecasting

For searching the shortest route on the network, defining the travel speed on each link of the network is necessary. In general, this definition should be dependent on traffic volume and can be specified by the so-called "QV function." This definition was established based on the Indonesian Highway Capacity Manual by taking such factors as city size, non-motorized vehicle occupancy, roadside friction, and area, into account. The QV function for urban areas is shown in Table 6.1.1and Table 6.1.2 for rural areas.

Table 6.1.1 QV Formula for Urban Areas

Functional Classification	No.	Lanes	One way	Urban Area								
				Maximum Speed (km/h)	Possible Capacity (pcu/hour)	City Size Factor	Non-motorized Vehicle Factor	Roadside Friction Factor	Base Capacity (pcu/hour)	Peak Ratio (%)	Grade Factor	Asgmt. Capacity (pcu/day)
Toll Road	1	6	Two way	90	2,300	1.00	1.00	1.00	2,300	9.0	1.00	153,000
	2	4	Two way	90	2,300	1.00	1.00	1.00	2,300	9.0	1.00	102,000
	3	3	One way	90	2,300	1.00	1.00	1.00	2,300	9.0	1.00	76,000
	4	2	One way	90	2,300	1.00	1.00	1.00	2,300	9.0	1.00	51,000
Arterial Road	5	8	Two way	60	2,300	1.00	0.98	0.90	2,029	10.0	0.70	113,000
	6	6	Two way	60	2,300	1.00	0.98	0.90	2,029	10.0	0.70	85,000
	7	6	One way	60	2,300	1.00	0.98	0.90	2,029	10.0	0.70	85,000
	8	4	Two way	60	2,300	1.00	0.98	0.90	2,029	10.0	0.70	56,000
	9	4	One way	60	2,300	1.00	0.98	0.90	2,029	10.0	0.70	56,000
	10	3	Two way	60	2,300	1.00	0.98	0.90	2,029	10.0	0.70	35,000
	11	3	One way	60	2,300	1.00	0.98	0.90	2,029	10.0	0.70	42,000
	12	2	Two way	60	2,300	1.00	0.98	0.90	2,029	10.0	0.70	23,000
	13	2	One way	60	2,300	1.00	0.98	0.90	2,029	10.0	0.70	28,000
Collector Road	14	6	Two way	50	2,300	1.00	0.95	0.86	1,879	11.0	0.60	61,000
	15	6	One way	50	2,300	1.00	0.95	0.86	1,879	11.0	0.60	61,000
	16	4	Two way	50	2,300	1.00	0.95	0.86	1,879	11.0	0.60	40,000
	17	4	One way	50	2,300	1.00	0.95	0.86	1,879	11.0	0.60	40,000
	18	3	Two way	50	2,300	1.00	0.95	0.86	1,879	11.0	0.60	25,000
	19	3	One way	50	2,300	1.00	0.95	0.86	1,879	11.0	0.60	30,000
	20	2	Two way	50	2,300	1.00	0.95	0.86	1,879	11.0	0.60	17,000
	21	2	One way	50	2,300	1.00	0.95	0.86	1,879	11.0	0.60	20,000
Secondary Arterial Road	22	8	Two way	50	2,300	1.00	0.90	0.86	1,780	11.0	0.60	77,000
	23	6	Two way	50	2,300	1.00	0.90	0.86	1,780	11.0	0.60	58,000
	24	6	One way	50	2,300	1.00	0.90	0.86	1,780	11.0	0.60	58,000
	25	4	Two way	50	2,300	1.00	0.90	0.86	1,780	11.0	0.60	38,000
	26	4	One way	50	2,300	1.00	0.90	0.86	1,780	11.0	0.60	38,000
	27	3	Two way	40	2,300	1.00	0.90	0.86	1,780	11.0	0.60	24,000
	28	3	One way	40	2,300	1.00	0.90	0.86	1,780	11.0	0.60	29,000
	29	2	Two way	40	2,300	1.00	0.90	0.86	1,780	11.0	0.60	16,000
	30	2	One way	40	2,300	1.00	0.90	0.86	1,780	11.0	0.60	19,000
Local Road	31	6	Two way	30	2,300	1.00	0.86	0.86	1,701	12.0	0.40	34,000
	32	6	One way	30	2,300	1.00	0.86	0.86	1,701	12.0	0.40	34,000
	33	4	Two way	30	2,300	1.00	0.86	0.86	1,701	12.0	0.40	22,000
	34	4	One way	30	2,300	1.00	0.86	0.86	1,701	12.0	0.40	22,000
	35	3	Two way	30	2,300	1.00	0.86	0.86	1,701	12.0	0.40	14,000
	36	3	One way	30	2,300	1.00	0.86	0.86	1,701	12.0	0.40	17,000
	37	2	Two way	30	2,300	1.00	0.71	0.86	1,404	12.0	0.40	7,000
	38	2	One way	30	2,300	1.00	0.71	0.86	1,404	12.0	0.40	9,000
	39	1	Two way	30	2,300	1.00	0.71	0.86	1,404	12.0	0.40	4,000

Source : Indonesian Highway Capacity Manual (IHCM)

Table 6.1.2 QV Formula for Rural Areas

Functional Classification	QV No.	Lanes	One way	Rural Area								
				Maximum Speed (km/h)	Possible Capacity (pcu/hour)	City Size Factor	Non-motorized Vehicle Factor	Roadside Friction Factor	Base Capacity (pcu/hour)	Peak Ratio (%)	Grade Factor	Asgmt. Capacity (pcu/day)
Toll Road	1	6	Two way	-	-	-	-	-	-	-	-	-
	2	4	Two way	-	-	-	-	-	-	-	-	-
	3	3	One way	-	-	-	-	-	-	-	-	-
	4	2	One way	-	-	-	-	-	-	-	-	-
Arterial Road	5	8	Two way	-	-	-	-	-	-	-	-	-
	6	6	Two way	70	2,300	0.88	0.98	0.90	1,785	11.0	0.80	77,000
	7	6	One way	70	2,300	0.88	0.98	0.90	1,785	11.0	0.80	77,000
	8	4	Two way	70	2,300	0.88	0.98	0.90	1,785	11.0	0.80	51,000
	9	4	One way	70	2,300	0.88	0.98	0.90	1,785	11.0	0.80	51,000
	10	3	Two way	70	2,300	0.88	0.98	0.90	1,785	11.0	0.80	32,000
	11	3	One way	70	2,300	0.88	0.98	0.90	1,785	11.0	0.80	38,000
	12	2	Two way	70	2,300	0.88	0.98	0.90	1,785	11.0	0.80	21,000
	13	2	One way	70	2,300	0.88	0.98	0.90	1,785	11.0	0.80	25,000
Collector Road	14	6	Two way	-	-	-	-	-	-	-	-	-
	15	6	One way	-	-	-	-	-	-	-	-	-
	16	4	Two way	60	2,300	0.88	0.95	0.86	1,654	12.0	0.70	38,000
	17	4	One way	60	2,300	0.88	0.95	0.86	1,654	12.0	0.70	38,000
	18	3	Two way	60	2,300	0.88	0.95	0.86	1,654	12.0	0.70	24,000
	19	3	One way	60	2,300	0.88	0.95	0.86	1,654	12.0	0.70	28,000
	20	2	Two way	60	2,300	0.88	0.95	0.86	1,654	12.0	0.70	16,000
	21	2	One way	60	2,300	0.88	0.95	0.86	1,654	12.0	0.70	19,000
Secondary Arterial Road	22	8	Two way	-	-	-	-	-	-	-	-	-
	23	6	Two way	-	-	-	-	-	-	-	-	-
	24	6	One way	-	-	-	-	-	-	-	-	-
	25	4	Two way	-	-	-	-	-	-	-	-	-
	26	4	One way	-	-	-	-	-	-	-	-	-
	27	3	Two way	-	-	-	-	-	-	-	-	-
	28	3	One way	-	-	-	-	-	-	-	-	-
	29	2	Two way	-	-	-	-	-	-	-	-	-
	30	2	One way	-	-	-	-	-	-	-	-	-
Local Road	31	6	Two way	-	-	-	-	-	-	-	-	-
	32	6	One way	-	-	-	-	-	-	-	-	-
	33	4	Two way	40	2,300	0.88	0.86	0.86	1,497	13.0	0.40	18,000
	34	4	One way	40	2,300	0.88	0.86	0.86	1,497	13.0	0.40	18,000
	35	3	Two way	40	2,300	0.88	0.86	0.86	1,497	13.0	0.40	11,000
	36	3	One way	40	2,300	0.88	0.86	0.86	1,497	13.0	0.40	13,000
	37	2	Two way	40	2,300	0.88	0.71	0.86	1,236	13.0	0.40	6,000
	38	2	One way	40	2,300	0.88	0.71	0.86	1,236	13.0	0.40	7,000
	39	1	Two way	40	2,300	0.88	0.71	0.86	1,236	13.0	0.40	3,000

Source : Indonesian Highway Capacity Manual (IHCM)

3) Demand Forecast Models

i) Trip Generation Model

The trip generation model consists of two submodels: one submodel for estimating the total number of trips produced in the study area and another submodel for the trip production and attraction of each traffic analysis zone. The former model can be established by analyzing the trip rate of individual attributes and the latter model can be established by analyzing the relationship between the number of current observed trips and the socio-economic indicators of each zone. The following tables show the parameters of these models.

Table 6.1.3 Trip Rate by Purpose

Trip Purpose	Trip Rate
To-work	0.35
To-school	0.27
Business	0.13
Private	0.37
To-home	1.12
Total	2.23

Source: 2009 Trip Diary Survey, JICA Study Team

Table 6.1.4 Trip Production and Attraction Model Parameters

Production/ Attraction	Trip Purpose		Constant	Population	No. of Markets	No. of Restaurants	No. of Stores	No. of Schools	Dummy	Correlation Coefficient
Production	To-work	Coefficient	729.4	0.2409						0.952
		t-value	4.6	50.1						
	To-school	Coefficient	291.1	0.1709						0.958
		t-value	2.7	53.5						
	Business	Coefficient	330.0	0.0915						0.969
		t-value	6.9	63.2						
	Private	Coefficient	962.6	0.2632						0.969
		t-value	6.9	62.5						
Attraction	To-work	Coefficient	1,396.6	0.1417			4.7273		15,348.5	0.839
		t-value	4.7	8.1			4.0		9.6	
	To-school	Coefficient	216.7	0.1234				58.5788	9,515.8	0.923
		t-value	1.5	14.8				5.2	12.0	
	Business	Coefficient	558.8	0.0584			1.5248		5,821.6	0.841
		t-value	5.0	8.9			3.4		8.7	
	Private	Coefficient	1,926.6	0.1188	387.2	3.7443				0.811
		t-value	5.5	5.2	4.8	2.7				

Source : JICA Study Team

The total number of trips can be estimated by multiplying the trip rate with the future population by trip purpose, while trip production and attraction can be estimated by inputting the variables of each zone into the following formula:

$$P_i^k = c + \sum_n x_i$$

$$A_j^k = c + \sum_n x_i$$

Where, P_i^k : Trip production of i zone with k purpose
A_j^k : Trip attraction of j zone with k purpose
x_i : variable such as population of i zone
c : Constant

ii) Trip Distribution Model

The trip distribution model estimates the number of distributed trips by a combination of origin and destination zones, i.e., OD matrices, based on the trip production and attraction by traffic analysis zone obtained from the previous step.

Generally, the OD matrix consists of two different elements, which can be calculated by using two different models, i.e., intrazonal and interzonal models.

$$T_{ii} = k \cdot e^{a \cdot Q_i + b \cdot A_i}$$

Where, T_{ii} : Intrazonal trips in zone of i
Q_i : Minimum trip production or attraction of zone i
A_i : Area of zone i (km^2)
a, b, k: Parameters

Table 6.1.5 Intrazonal Model Parameters

Trip Purpose	Variables	Minimum of Prod or Attr	Area	Constant	Correlation Coefficient
		a	b	k	
To work	Coefficient	1.0044	0.2632	-1.2299	0.9097
	t-value	27.6	9.9	-4.5	
To school	Coefficient	0.9489	0.1737	-0.2744	0.9535
	t-value	41.4	9.7	-1.6	

Source : JICA Study Team

$$T_{ij} = k \cdot \frac{P_i^a \cdot A_j^b}{d_{ij}^c}$$

Where, T_{ij} : Trip distribution between zones of i and j
P_i : Trip production of zone i
A_j : Trip attraction of zone j
d_{ij} : Travel distance between zones of i and j
a, b, c: Parameters

Table 6.1.6 Interzonal Model Parameters

Trip Purpose	Variables	Production	Attraction	Distance	Constant	Correlation Coefficient
		a	b	c	k	
To work	Coefficient	0.2752	0.1977	-0.3567	2.0685	0.6760
	t-value	27.9	23.0	-37.1	6.7	
To school	Coefficient	0.2624	0.1884	-0.4056	3.0767	0.6689
	t-value	17.6	14.3	-27.6	7.0	

Source : JICA Study Team

iii) Modal Split Model

The previous trip distribution model calculates the number of trips that will be made between traffic analysis zones. The modal split model estimates the transportation modes that will be used in traveling between traffic analysis zones. As mentioned in the previous section, three different split models were established in this study, as follows:

$$P_{ij}^{walk} = e^{a \cdot d_{ij}^2 + b \cdot d_{ij} + c}$$

Where, P_{ij}^{walk} : Share of walk trips between zones of *i* and *j*
d_{ij} : Travel distance between zones of *i* and *j*
a, b, c: Parameters

Table 6.1.7 Walk Trip Split Model Parameters

Trip Purpose	Variable	Square of *dij*	*dij*	Constant	Correlation Coefficient
		a	*b*	*c*	
To-work	Coefficient	0.0098	-0.3339	-1.2399	0.99
	t-value	1.7	-6.1	-11.7	
To-school	Coefficient	-0.0194	-0.0954	-0.5718	0.99
	t-value	-4.2	-2.1	-6.6	

Source : JICA Study Team

$$P_{ij}^{PT} = \frac{1}{e^{a \cdot O_i^{Veh} + b \cdot \frac{T_{ij}^{PT}}{T_{ij}^{Veh}} + c}}$$

Where, P_{ij}^{PT} : Share of public transportation mode between zones of *i* and j
O_i^{Veh} : Vehicle ownership in zone *i*
T_{ij}^{PT} : Travel time by public transportation between zones of *i* and *j*
T_{ij}^{Veh} : Travel time by vehicle between zones of *i* and *j*
a, b, c: Parameters

Table 6.1.8 Public Transportation Split Model Parameters

Trip Purpose	Variable	Vehicle Ownership	Travel Time Ratio	Constant	Correlation Coefficient
		a	*b*	*c*	
To-work	Coefficient	4.9849	0.2677	-2.2304	0.79
	t-value	11.2	1.8	-4.8	
To-school	Coefficient	1.8440	0.3215	-0.3999	069
	t-value	3.2	2.0	0-.6	

Source : JICA Study Team

$$P_{ij}^{Car} = \frac{1}{e^{a \cdot O_i^{Car} + b \cdot \frac{T_{ij}^{Car}}{T_{ij}^{MC}} + c}}$$

Where, P_{ij}^{Car} : Share of private car between zones of *i* and *j*
O_i^{Car} : Private car ownership in zone *i*
T_{ij}^{Car} : Travel time by private car between zones of *i* and *j*
T_{ij}^{MC} : Travel time by motorcycle between zones of *i* and *j*
a, b, c: Parameters

Table 6.1.9 Private Car Split Model Parameters

Trip Purpose	Variable	Vehicle Ownership	Travel Time Ratio	Constant	Correlation Coefficient
		a	*b*	*c*	
To-work	Coefficient	-4.3051	0.2016	3.0611	0.85
	t-value	-4.3	1.9	17.2	
To-school	Coefficient	-3.2576	0.0111	3.4420	0.79
	t-value	-6.7	1.1	10.1	

Source : JICA Study Team

iv) Traffic Assignment

For assigning traffic on the road network, the traditional incremental assignment module in the JICA STRADA was applied. The incremental assignment divides OD traffic demand data into appropriate increments and assigns each increment to the shortest route with the least generalized cost.

Figure 6.1.4 shows an example of incremental assignment. In this case, the OD matrix was divided twice, i.e., 60% for the first time and 40% for the second time. First, travel time with free flow speeds at each link was calculated and the shortest routes, shown by red lines in the figure, in the travel time between zones are found. Second, the travel demand in the first OD matrix are assigned on the shortest routes, and travel time at each link is re-calculated with the traffic volume assigned by QV equation pre-defined at each link. This iteration is repeatedly done until the designated calculation times, two times in this example, is achieved.

OD Matrix (pcu)

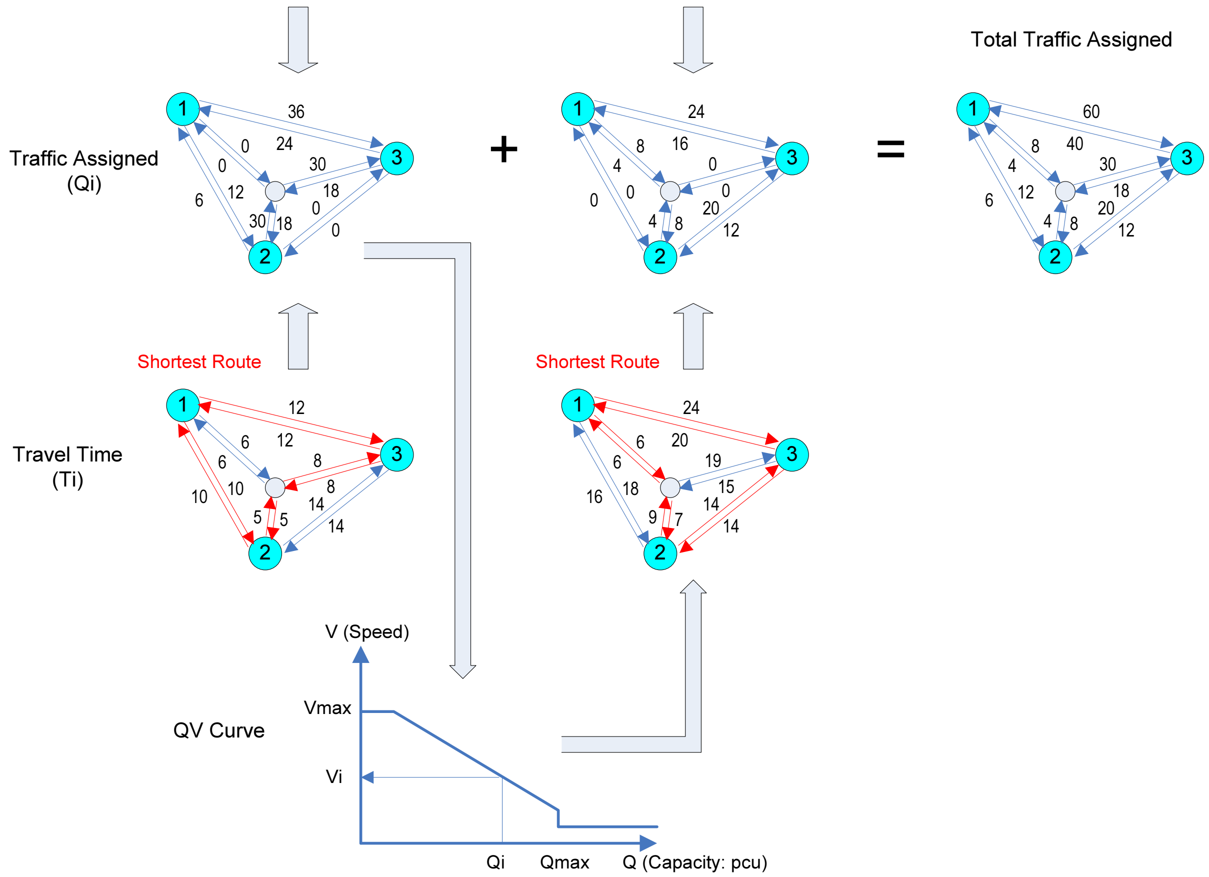
	1	2	3
1		20	60
2	10		50
3	40	30	

1st Time: 60%

	1	2	3
1		12	36
2	6		30
3	24	18	

2nd Time: 40%

	1	2	3
1		8	24
2	4		20
3	16	12	



Source : JICA Study Team

Figure 6.1.4 Example of Incremental Assignment

6.2 Demand Forecasting

1) Total Trips Estimated in the Future

The first step in forecasting demand is to identify the total number of trips traveling in the study area. For this task, the JICA Study Team applied the trip rate by travel purpose shown in Table 6.1.3. The forecast shows that the number of trips generated in GKS by 2030 is 31 million person trips per day, which is 1.5 times of the existing number, as estimated based on the surveys.

Table 6.2.1 Total Number of Future Trips

Trip Purpose	Trip Rate	No. of Trips (1,000)			
		2009	2010	2020	2030
To-work	0.35	3,231	3,362	4,155	4,881
To-school	0.27	2,484	2,585	3,195	3,752
Business	0.13	1,226	1,276	1,577	1,852
Private	0.37	3,497	3,639	4,497	5,282
To-home	1.12	10,438	10,862	13,425	15,767
Total	2.23	20,876	21,724	26,849	31,535
Increase		1.00	1.04	1.29	1.51

Source : JICA Study Team

2) Future OD Matrix

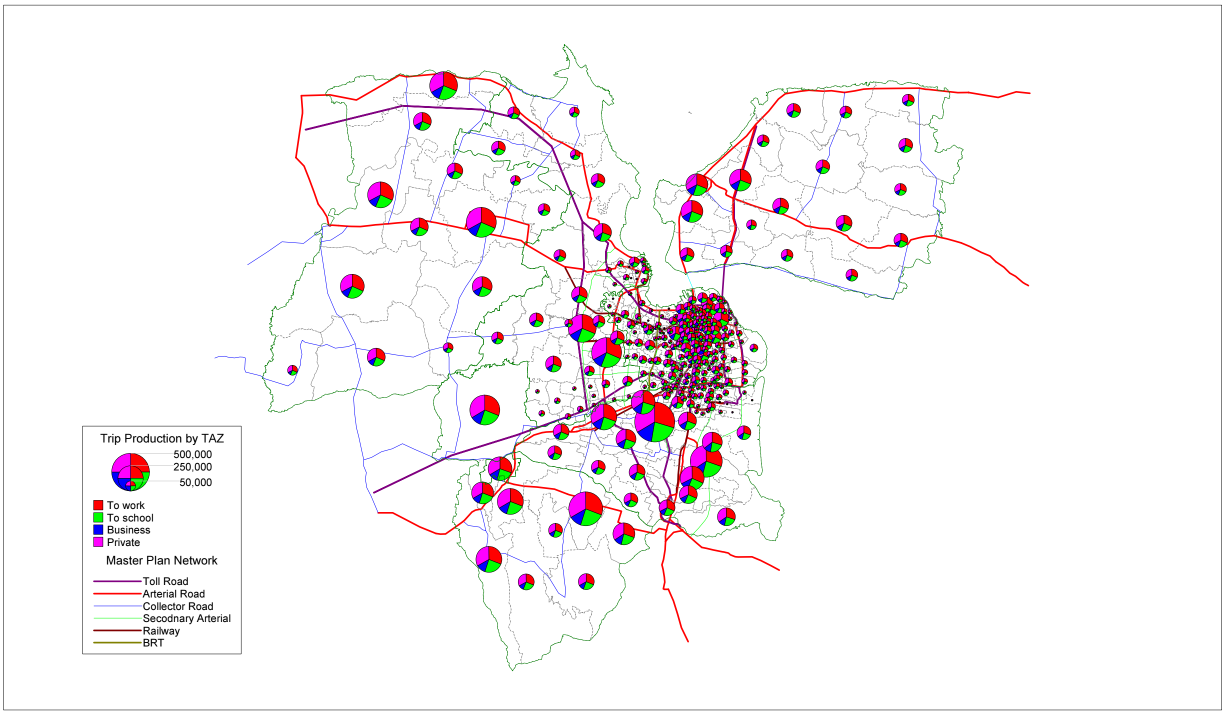
Next, the trips produced by and attracted to each traffic analysis zone were calculated by using the models described in the previous section. Then, the above total number of trips generated was distributed to each zone in proportion with the model value calculated with the trip production and attraction models.

Source : JICA Study Team

Figure 6.2.1 through

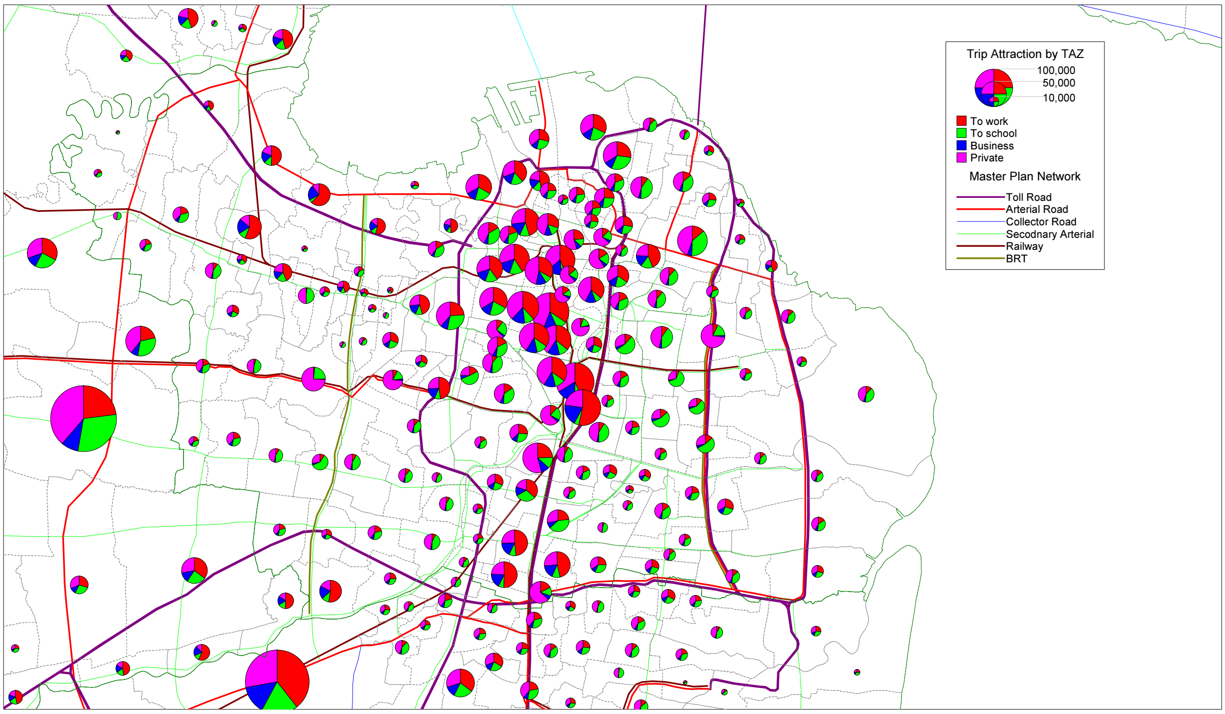
Source : JICA Study Team

Figure 6.2.4 show the trips produced by and attracted to each traffic analysis zone.



Source : JICA Study Team

Figure 6.2.1 Trip Production by Traffic Analysis Zone



Source : JICA Study Team

Figure 6.2.2 Trip Production in Central Surabaya by Traffic Analysis Zone